Resection of the Posterior Spinal Nerve-roots in the Treatment of Gastric Crises and Spastic Paralysis.

By Professor FOERSTER (Breslau).

FIRST of all I wish to thank you most sincerely for your kind invitation to this meeting of the Surgical Section of the Royal Society of Medicine. I am conscious of the great honour you have bestowed upon me by allowing me to attend your illustrious assembly. I would also express my deepest gratitude to Mr. Groves for his kind words of welcome and for his having so kindly occasioned my taking part in this present discussion, since the scientific topic which is treated to-day has been especially furthered by English workers from the beginning. I need not remind you that Sir Victor Horsley was the first to open the dura of the spinal cord, and Sir W. H. Bennett, of London, was the first to divide posterior spinal nerve-roots, on December 24, 1888. I should like to express emphatically that my own modest researches, too, on this subject have received the greatest stimulus from English workers, especially from the discoveries of Sherrington and Head. I need not mention before this audience how much we are indebted to Sherrington for all our knowledge of the physiology of the posterior spinal nerve-roots, and that the work of Head on the disturbances of sensation in diseases of the viscera represent the most valuable documents of our knowledge of the sensory nerve supply to the internal organs.

(1) Resection of the posterior spinal nerve-roots for the relief of pain has already been carried out in the past in a considerable number of cases. After Bennett, who divided four lumbar and one sacral posterior nerve-roots in a case of sciatica, the operation has been performed by Abbe and Munro in several cases of neuralgia of the brachial plexus, by Sir Victor Horsley in two cases of severe neuralgia of the arm, by Chipault, Demoulin and Monod in five cases of neuralgia of the arm, by Giordano in a case of sciatica, and by Faure in a case of cancer of the uterus. In three cases of cancer of the spinal column Tietze and I performed resection of the posterior roots in order to relieve the fearful pain which radiated from these roots; but the results were only successful for a short time, since, owing to the progress of the disease, other roots were subsequently attacked. In 1900,

Mingazzini suggested resection of the posterior nerve-roots in cases of locomotor ataxia with severe lightning pains, but the operation was not actually performed until recently, when Hildebrand, in 1910, cut two cervical nerve-roots in a patient suffering from tabes: a relapse occurred. Enderlen performed resection of certain thoracic roots for severe girdle pain. Mr. Groves has also to-day reported to you on a case in which the pain remained. Last summer, Gottstein and I cut the fourth and fifth lumbar and first sacral roots in a tabetic patient suffering from a perfectly localized neuralgia of the internal malleolus; for some weeks there was complete absence of pain, but afterwards it recurred as badly as before. I am inclined to believe that if resection of the posterior nerve-roots is to be performed at all in cases of tabes with lightning pains, it will be necessary to remove all the roots of one extremity at once; for we never know with absolute certainty which roots are particularly influenced by the morbid stimuli, and there is considerable overlapping of the regions supplied by the different roots. Thus, in our case of tabes, the resection of three roots was not followed by any sensory disturbance.

(2) When I suggested performing resection of certain posterior thoracic roots in cases of visceral crises I was influenced by a consideration of the severe pain and symptoms of sensory irritation which form the basis of these crises, and of the often enormously increased hyperæsthesia of the skin of the epi-, meso-, and hypogastrium which accompany the crisis. In the manner in which patients are wont to describe and localize the pain in gastric crises, and in the abdominal hyperæsthesia, such crises show a marked resemblance to the sensory symptoms observed in certain organic diseases of the stomach, notably gastric ulcer, as well as diseases of the liver, gall-bladder, and intestine. With these diseases also, marked hyperæsthesia of certain parts of the chest and abdomen occurs very frequently, as has been shown by the classical investigations of Head. I was thus led to the view that the gastric and intestinal crises in tabes were caused by an irritation of the sensory sympathetic fibres of these organs which enter the spinal cord through certain posterior thoracic roots. Supposing this view to be correct, the crises would cease after the resection of these roots.

The operation has now been performed altogether twenty-eight times, as shown by Table I (p. 228). Three cases succumbed to the immediate effects of the operation, two showed no improvement, the crises persisting. In the remaining twenty-three cases the operation was successful. Immediately after the resection of the roots the

crises disappeared, the body-weight increased, and the general condition showed a marked improvement: some of the patients who, until then, had been absolutely confined to their bed for some time, have since regained their power to work. In the majority of these cases (fifteen) no relapse has been reported. We must add still the case reported by Mr. Hey Groves to-day. The period which has elapsed since the operation is shown in the table. In several of these cases there has been no recurrence of the crises for many months, and even for over a year, although before the operation a continuous critical state had persisted. In the remainder of the cases (seven) the crises

TABLE I.—GASTRIC CRISES.

28 cases			25 survived		3 deaths
			23 successful		2 not benefited
				Interval between operation and publication	
No relapse	15 cases	Küttner	(1)	5 months	
		Küttner	(1)	1⅓ years	
		Bierens de Haan	(1)	7 weeks	
		Goetzel	(1)	3 months	
		Becker	(1)	3 months	
		Guleke	(1)	2 months	
		Nonne	(2)	Not stated	
		Sänger	(1)		
		Tick	(2)		
		Bornhaupt	(1)		
		Thomas-Hall	(1)		
		Franke	(1)		
		Frankl-Hochwart	(1)		
Relapse	8 cases	Sauerbruch	(1)		
		Tietze-Foerster	(3)		
		Guleke	(3)		
		Mainzer	(1)		

ceased for a while, but subsequently recurred. Yet even in these the critical state has not returned. The crises only occur occasionally, at long intervals; they are of short duration and moderate intensity. Among this latter group of cases are three patients who have even regained the power of earning their living, one of them being an architect and one a mason.

If in a number of cases the result of the operation is not perfect, it is to be attributed to the fact that the system of roots carrying sympathetic nerve-fibres of gastro-intestinal origin is very extensive. By the method which has hitherto been practised of only cutting from the seventh to the ninth or the seventh to tenth thoracic roots the source of the crises has not always been entirely eliminated. Probably the

fifth and sixth as well as the eleventh and twelfth thoracic roots are also concerned. It is therefore desirable to remove as many of the nerve-roots as possible, although this increases the gravity of the operation. What is even more important, is in every case to determine exactly the situation of the pain, the extent of the hyperæsthesia of the skin and the site of its maximum intensity, since these data may possibly afford a guide as to which roots are chiefly irritated and concerned in causing the crises. In this connexion a publication by Guleke

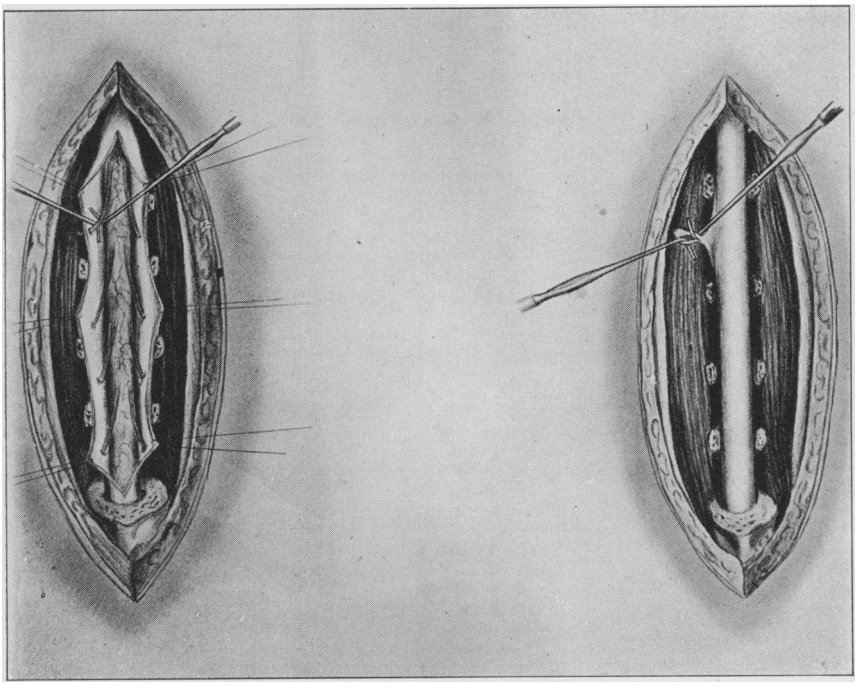


FIG. 1. FIG. 2.

is of interest: in one patient the crises disappeared for a time after the resection of the seventh to the ninth thoracic roots. They recurred, but again disappeared after the resection of the tenth and eleventh thoracic roots. For such extensive resections Guleke's method would appear to be particularly well suited. While ordinarily the dura is opened and the posterior thoracic roots are resected close to the spinal cord—as is shown in fig. 1—Guleke does not open the dura, but picks up the roots in their course outside the dura (fig. 2). Here also the anterior and posterior roots are enclosed in separate sheaths separable

from one another with comparative ease. The posterior roots are then cut.

We must, however, bear in mind that gastric crises may possibly arise from irritation of the pneumogastric nerve and perhaps even of the vomiting centre in the medulla. All cases of gastric crises without any pain should be regarded as suspicious and as unsuitable for resection of the posterior nerve-roots.

(3) I will now discuss the value of resection of the posterior spinal nerve-roots in spastic paralysis due to disease of the cortico-spinal path,

TABLE II.—SPASTIC PARALYSIS.

81 cases ... ... 72 survived ... ... 9 deaths

51 *cases of congenital spastic paraplegia* (*Little's disease*)—
45 successful; 1 not benefited; 5 deaths

3 *cases of acquired cerebral spastic paraplegia*—
All successful

4 *cases of spinal spastic paralysis of traumatic origin*—
2 successful; 2 not benefited: 1 case, wrong roots divided (11 Th., 12 Th., 1 L.); 1 case, complete interruption of the cortico-spinal tracts

1 *case of spastic paraplegia from compression of the spinal cord* (*Pott's disease*)—
Successful

2 *cases of syphilitic spastic paraplegia*—
Successful

1 *case of primary spastic paraplegia* (?) (*Erb-Charcot*)—
Successful

6 *cases of disseminated sclerosis*—
3 deaths; 1 case not benefited; 1 case successful, disease rapidly progressing, death; 1 case successful

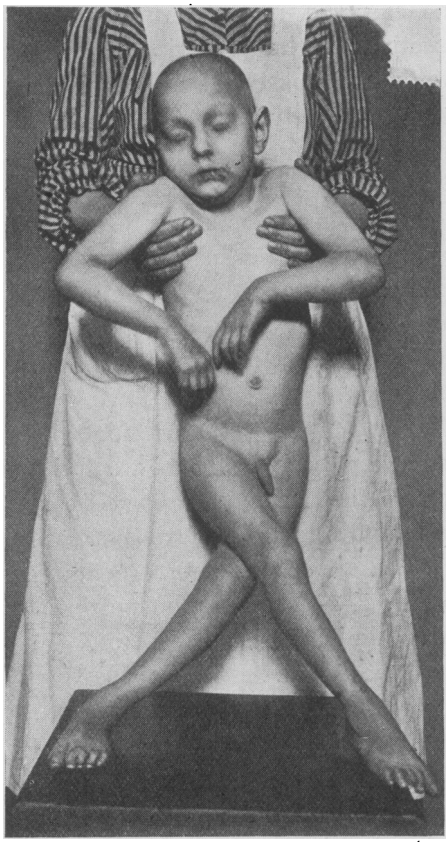
12 *cases of spastic paralysis of the arm*—
1 death; 8 cases benefited; 3 cases not successful—complete interruption of the cortico-spinal tracts

especially the pyramidial tract. These paths carry two kinds of fibres—firstly, those bearing the motor impulse, injury to which causes paresis or paralysis, and secondly, the inhibitory fibres which check the sensory stimuli entering into the grey matter of the spinal cord by the sensory nerve-roots. When the inhibitory fibres are damaged, the sensory afflux acts unrestrained upon the muscles, thus causing the spastic symptoms. If in such cases the posterior roots—that is to say, the path of afferent sensory impulses—are cut, the excess of sensory impulses is again reduced and the spastic symptoms are diminished or may even disappear

completely. Frequently the fibres carrying the motor impulses are *still fairly intact.* In such cases resection of the posterior roots is followed by a complete disappearance of the spasms, and all those voluntary movements which were before so seriously interfered with by the spastic resistance of the muscles are now executed without any difficulty. We may therefore conclude that the operation can only be successful where voluntary excitability of the muscles is still present to a certain extent. Further, this treatment can only cure those spastic conditions of the muscular system which are actually due to the influx of excessive *sensory* stimuli to the grey matter of the cord—i.e., only in true *reflex* spastic contraction of the muscles. On the other hand, resection of the posterior nerve-roots cannot be successful in the muscular contractions of athetosis, chorea, mobile spasms; for this latter class of diseases, which have so often been confused with the former, are due to the direct pathological stimulation of *motor* centres and paths belonging to the cerebrum and mid-brain: they are therefore comparable to the epileptic convulsions which arise from a corresponding irritation of the motor centres of the brain. Resection of the posterior roots cannot eliminate the pathological stimulus of these centres. In all such cases it has therefore proved unsuccessful.

The operation has hitherto been performed in eighty-one cases, as is shown by Table II. Of these, nine died as the result of the operation; seventy-two survived. Fifty-one were cases of congenital spastic paraplegia (Little's disease): almost all these patients have been benefited by the operation, some of them showing a marked improvement. I should like to demonstrate to you in pictures the extent of this improvement in some cases. The patients in question were operated upon by Küttner, a part only of these cases having been published.

Case I.—Boy, aged 7. Severest rigidity of the limbs (fig. 3), unable to make the slightest voluntary movement, to sit, stand, or walk; the patient lay in bed like a log. Preliminary orthopædic treatment, consisting in tenotomy of the Achilles and adductor tendons, had been absolutely of no avail. In consequence the legs were now held in extreme abduction (fig. 4) with the same rigidity as they had previously been held in adduction. The result of the operation of root division was immediate cessation of the spasms and the return of voluntary motility. The boy now moves his legs freely, he even lifts one leg alone without any assistance (fig. 5), he can stand erect with straight knees unaided (fig. 6), and walks quickly and safely on two crutches



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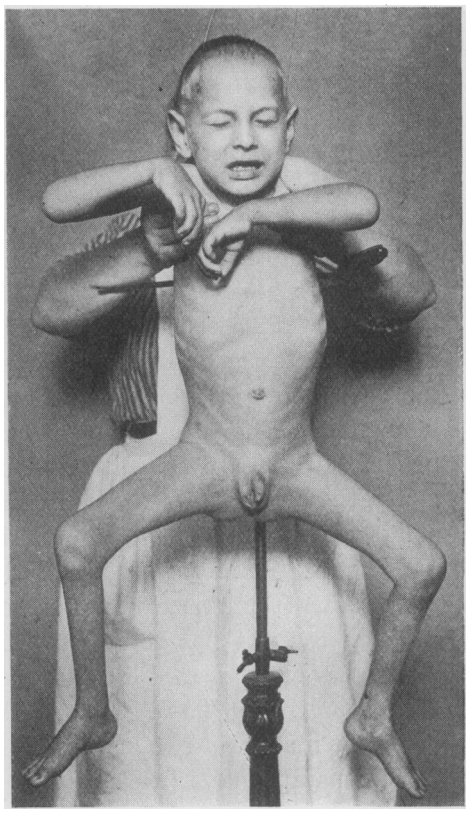

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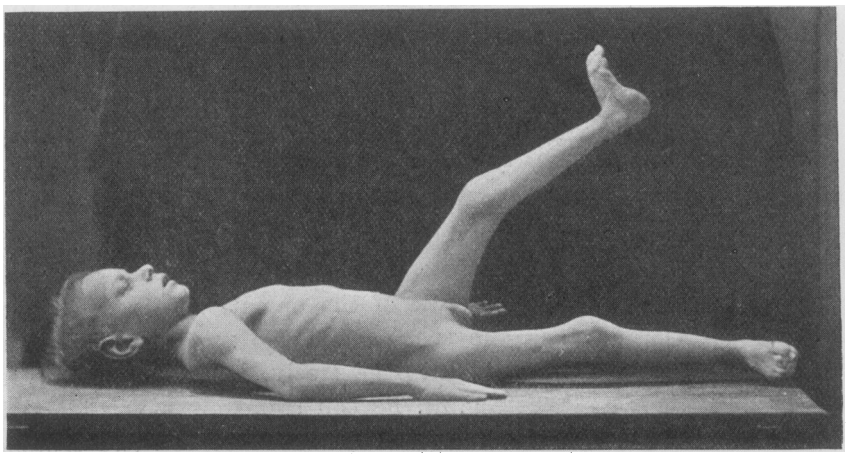


FIG. 5.

without any help. The improvement was maintained under the use of suitable exercises, and is still going on.

Case II.—Boy, aged 11. Severest rigidity; was able to carry out slight voluntary movements of the legs, but could only bend both legs a little at the same time (fig. 8), considerable subsidiary movements being

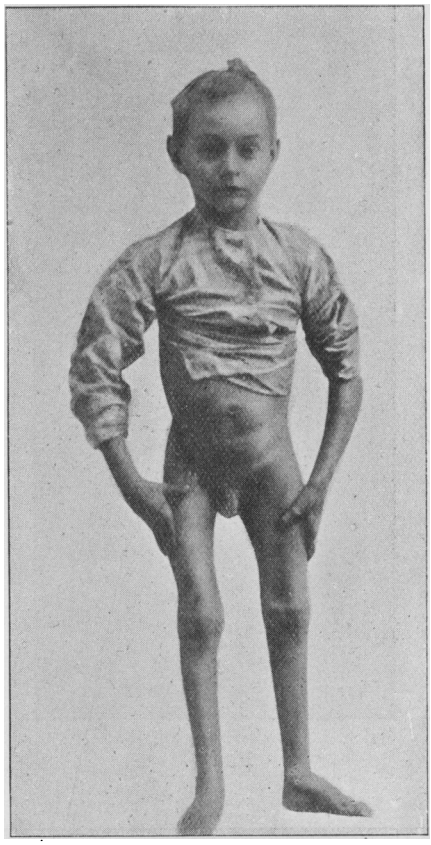
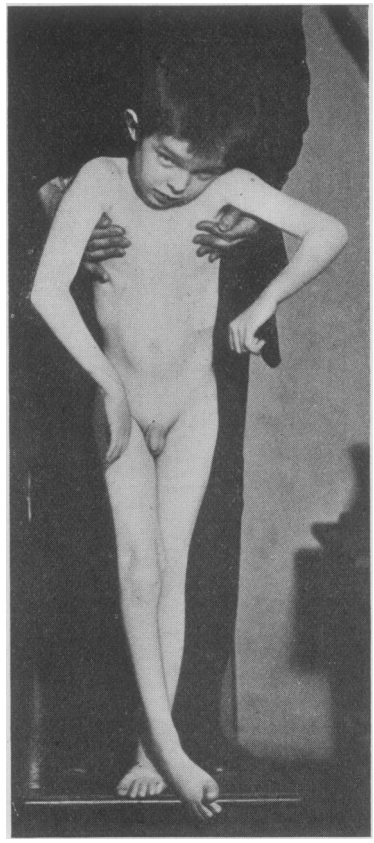


FIG. 6.

carried out with the arms and head. The patient was quite unable to stand (fig. 7) or to walk, and could not sit up even when assisted, the resistance of the extensors of the pelvis being insurmountable (fig. 9). After the operation the rigidity has quite disappeared; voluntary movements of the legs are carried out freely, the patient being able to bend each leg by itself (fig. 10), to lift it up high without also bending the

knee and ankle-joint (fig. 11); he sits up alone (fig. 12), stands (fig. 13), and walks alone with long strides (fig. 14).



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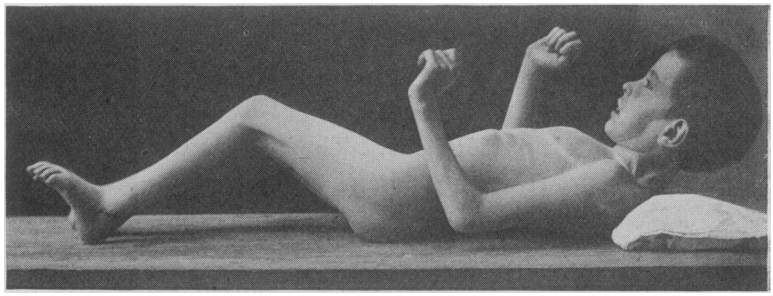

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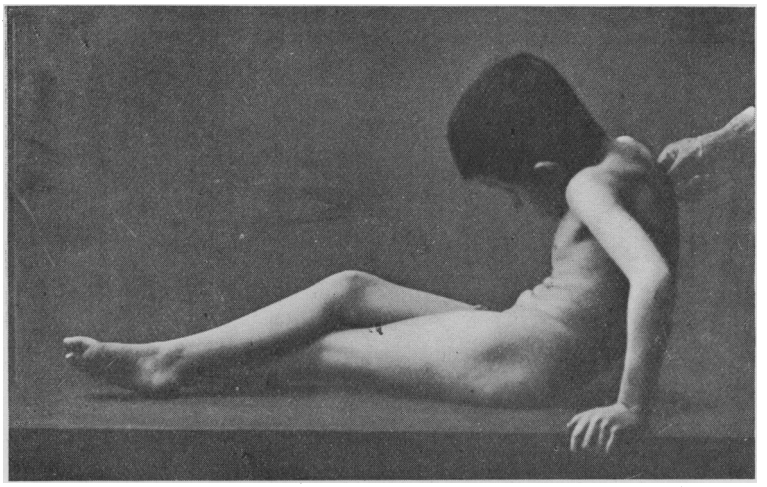

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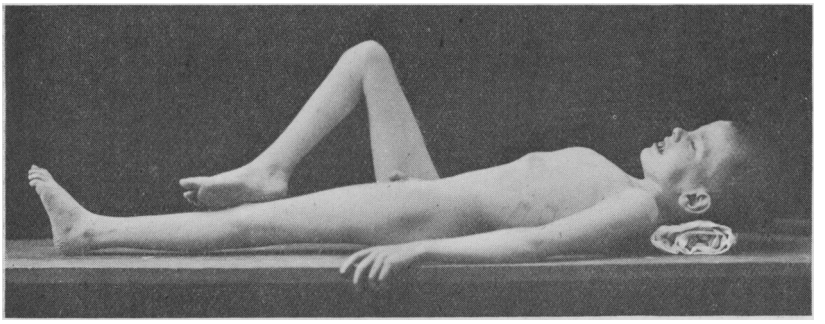

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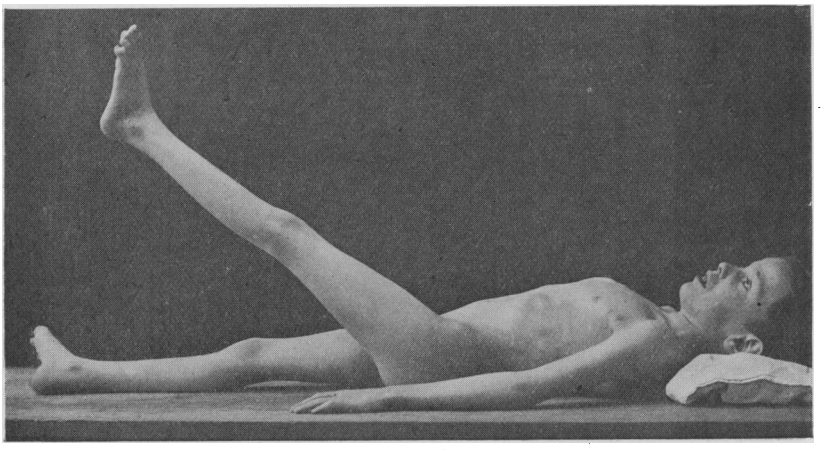

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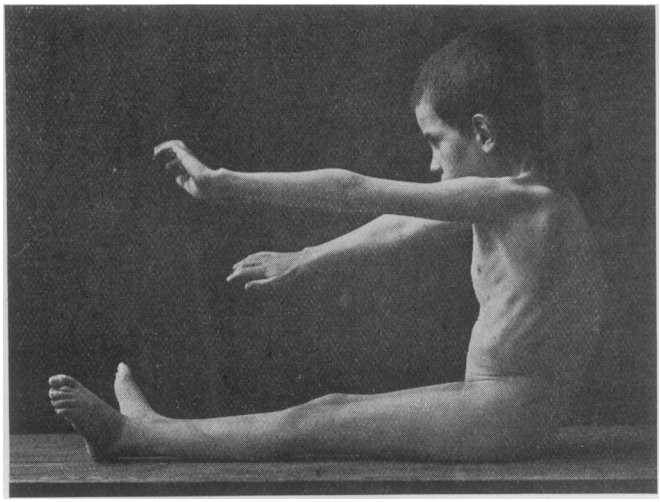

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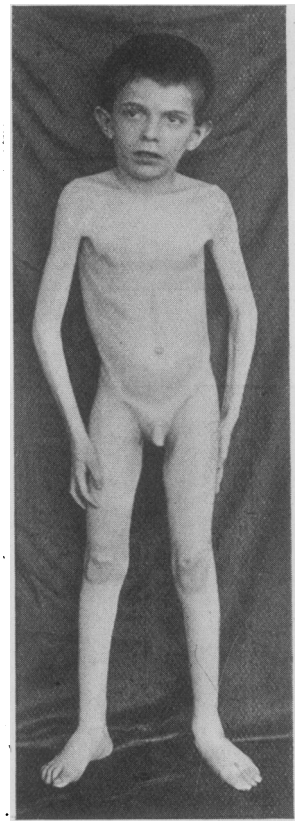

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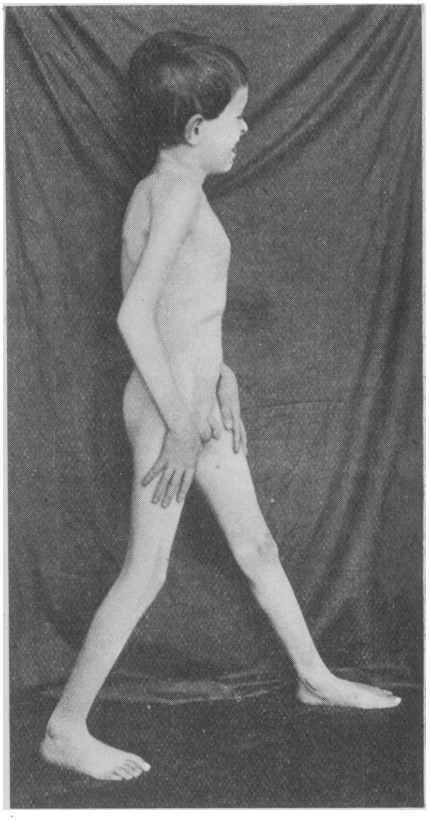
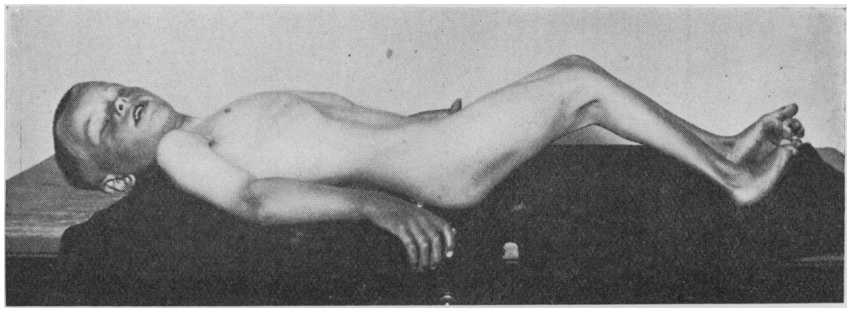


FIG 14.

Case III.—Boy, aged 10, with severe rigidity of the limbs and contraction of the flexors (fig. 15). Motility as in the previous case: the patient was unable to sit, stand (fig. 16), or walk. After the operation the spasticity quite disappeared, and perfectly free motility was



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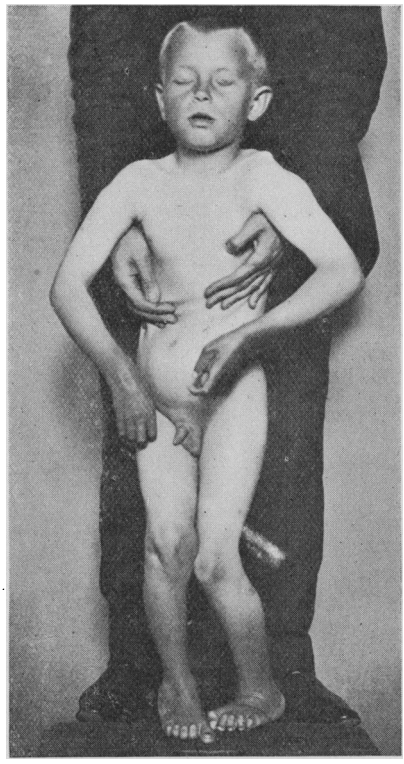

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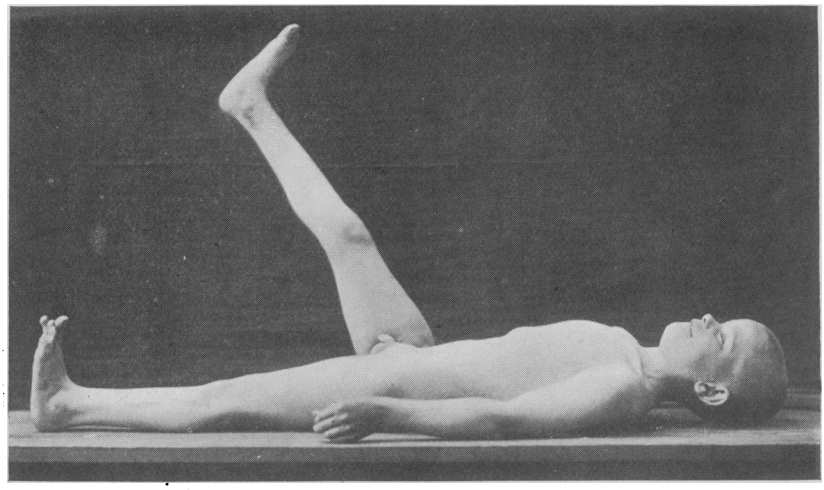

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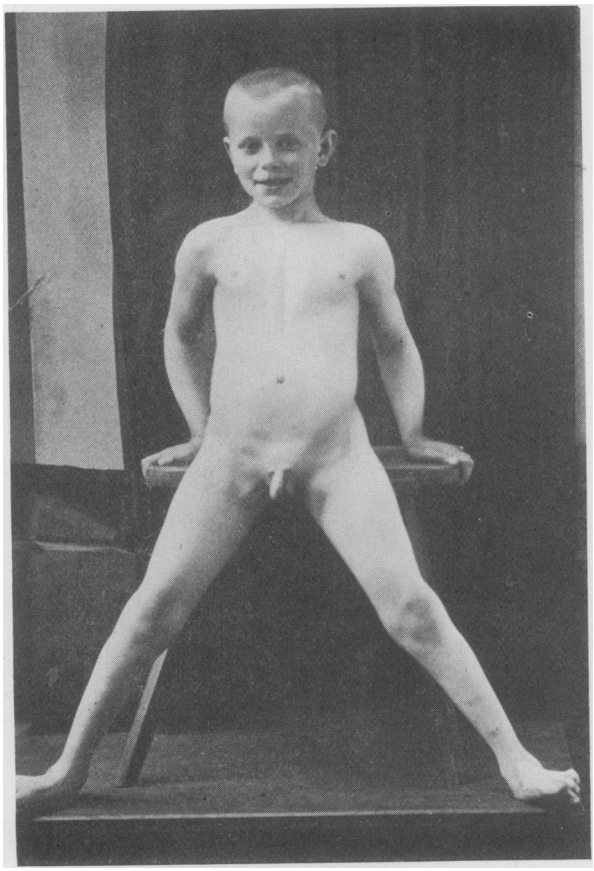
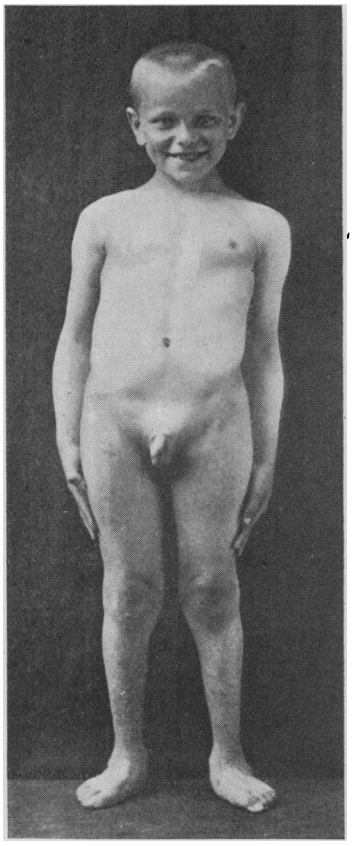


FIG. 18.

obtained, the patient being able to bend each leg independently or to lift it high up (fig. 17), and to abduct the legs widely (fig. 18); the patient stands alone (fig. 19) and he walks alone with long steps (fig. 20), he bends the leg well in walking (fig. 21) and steps well forwards (fig. 22), mounts stairs without fatigue, and is out alone in the open for many hours.



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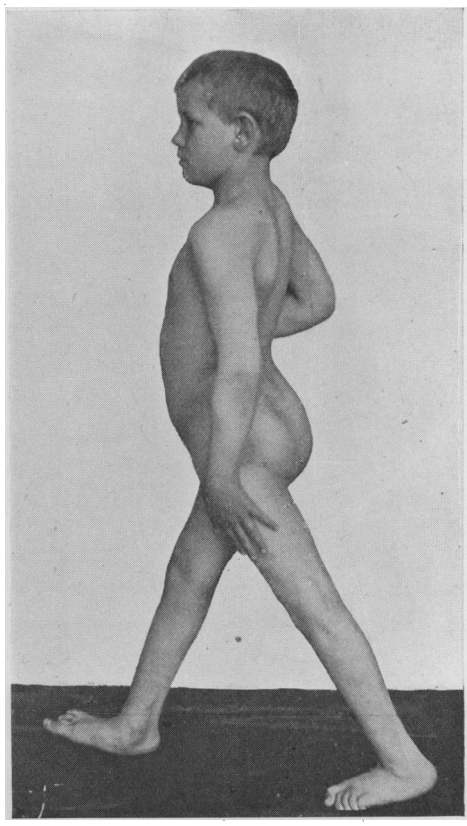
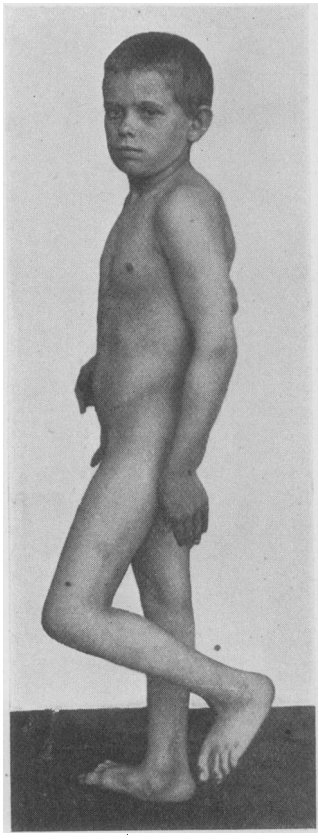


FIG. 20.

Case IV.—Unpublished case. Severest spastic paralysis of all four limbs, figs. 23 and 24 showing how arms and legs were inextricably interlocked, as it were, in a tangle. The patient was totally unable to carry out any voluntary movement, lay in bed huddled up, and in addition suffered from athetosis. Root resection was carried out here both in the lumbo-sacral and the cervical part of the cord. The

spasms were greatly improved; the patient can now lift up each leg separately (fig. 25); in standing (fig. 26) and walking he has still to be supported on both sides, since the operation was carried out comparatively recently, but he walks in this way with long steps. The patient voluntarily lifts each arm up high (fig. 27), and can use his hands



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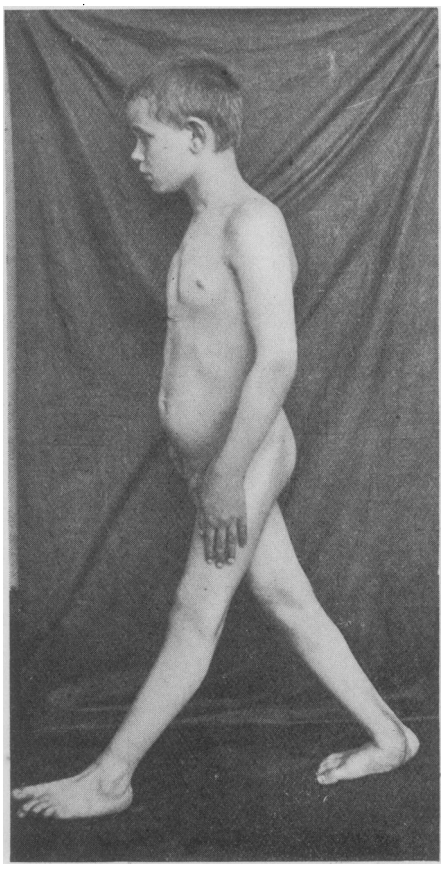
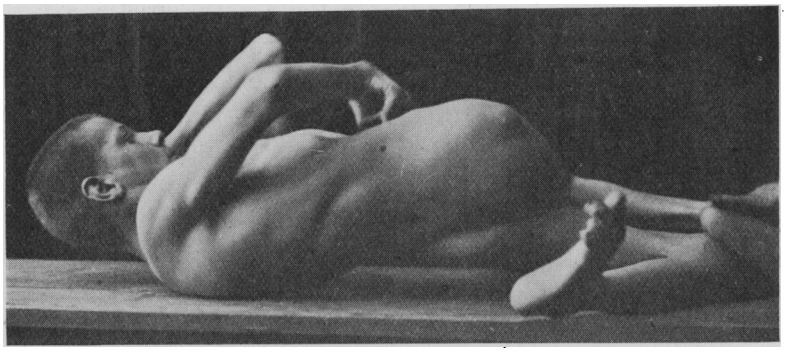


FIG. 22.

in eating and drinking. In another similar case of spastic diplegia Küttner and I have performed resection of the cervical as well as the lumbar roots.

On returning to a consideration of our table, we next find the following cases: Three patients with acquired cerebral spastic paralysis, all of which were treated successfully, one of them being a case of



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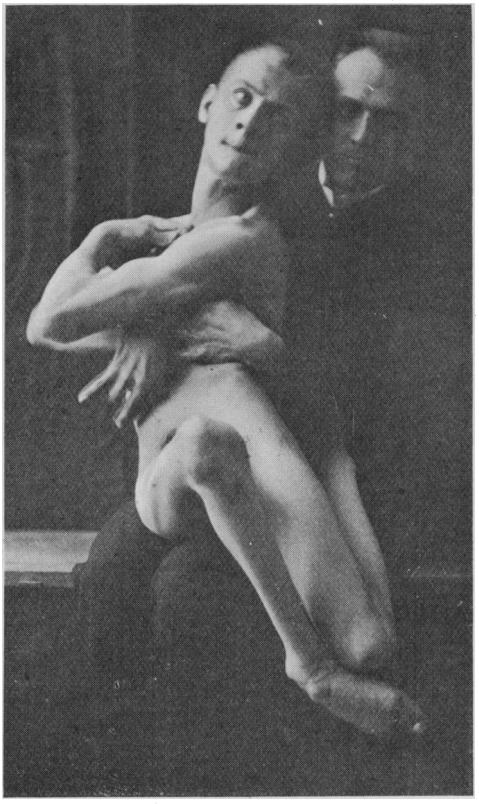

FIG. 24.

hydrocephalus with severe spastic paraplegia. There is also a considerable number of cases of spinal disease with spastic symptoms. Of four cases of spinal spastic paralysis of traumatic origin, two were successful; of the remaining two, which were failures, in one wrong roots were cut, whilst in the other the cortico-spinal fibres appear to have been completely interrupted; in this case the spasms disappeared, but voluntary motility did not return.

In addition there is one case of Pott's disease which was successful, also two cases of syphilitic spastic paraplegia, successful; two cases of

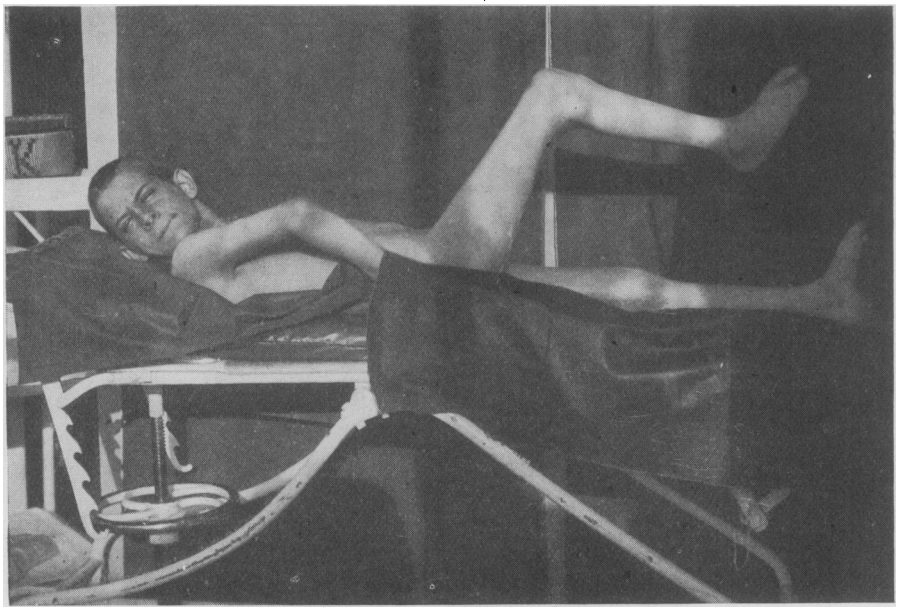

FIG. 25.

primary spastic paraplegia (Erb-Charcot), successful; of six cases of disseminated sclerosis, three died as the result of the operation, one was not benefited, one was at first successful, but subsequently the disease progressed rapidly and the patient died; the sixth was benefited.

Of twelve cases of spastic paralysis of the arm, one died, eight were successful, one of these being the Case IV already demonstrated; the remaining three were not benefited owing to complete interruption of the cortico-spinal path; in these patients the spasms disappeared, but voluntary motility did not return.

These comprise the cases to my knowledge.

There remain still a few points to which I would call your attention. As regards the indications of the operation I must, in the first place, repeat that only lesions with real reflex spasticity as the result of the loss of the cortico-inhibitory fibres are suitable, but not the diseases of

FIG. 26.

FIG. 27.

the type of chorea, athetosis, mobile spasm and spasmodic torticollis. Lately, Abbe recommended *posterior* spinal nerve-roots division for the relief of athetosis, and quotes a case as proof in which he, in addition to the resection of posterior roots for the relief of pain, also resected four *anterior (!)* roots for the relief of athetosis, as he expressly says in his first publication of the same case in 1896. Often athetosis is

combined with real reflex spasticity; in such cases the resection of the posterior roots removes the spasticity, whilst the athetosis does not disappear, or only for a short time. Possibly Parkinson's disease may be suitable.

Secondly, there must be a reasonable prospect of innervating fibres of the pyramidal tract still existing, all cases with slight spasms and considerable paralysis being unsuitable. In cases of severe spasms and total voluntary paralysis there may remain a considerable amount of voluntary excitability only obscured by the spasms and only apparent after their elimination. In such cases the experiment is worth trying. The question whether any voluntary motility remains may be decided by preliminary injection of stovaine, which temporarily removes the spasms. The arm, as a general rule, is less suitable than the leg. Thirdly, the disease must have become practically stationary, whilst progressive diseases like disseminated sclerosis are hardly suitable, very slowly progressing ones like spastic spinal paralysis being perhaps more promising.

The second point to which reference should be made is the after-treatment of the patient. Good results can only be obtained with very careful exercise treatment. It is only by such exercises that voluntary motility is brought up to its highest level, and that, above all, standing and walking are gradually rendered possible. Such exercises should be continued for years, during which continuous progress may be observed. The assistance of orthopædic measures cannot be dispensed with; above all, it is necessary to place the limbs in removable plaster splints in such a position as to correct the previous deformity; the legs in abduction, extension and outward rotation, the knees in extension, the feet in dorsal flexion, the arms in abduction, the forearms in extension, the hands in supination and extension, the fingers in extension, the thumbs in opposition. These positions are required during the whole time immediately following the operation, the limbs being only removed from their plaster cases for the purpose of the exercises, which should be carried out several times a day; later on they should still be kept in the splints at night.

If beside the real spastic contractions there are also organic contractions due to shrivelling of the muscles and tendons, tenotomy or tenoplasty may also have to be performed. As to the technique of the operation, I am fully convinced that Mr. Groves's proposal for the use adrenalin is of the greatest importance, as the bleedings often assume a threatening character. It seems to me also that his method of cutting

the roots nearer to the spinal cord simplifies the operation, although it renders it more difficult to distinguish the different roots.

In conclusion, Mr. President and Gentlemen, let me thank you for the kind attention with which you have honoured me and the leniency with which you have regarded my inefficient use of your language.

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